LA-UR-18-27513
Approved for public release; distribution is unlimited.

Title: Genetic Algorithm Based Critical Experiment Design for Uranium Cross Section Validation

Author(s): Fritz, Dominik Arthur

Intended for: Keepin nonproliferation summer program

Issued: 2018-08-07

Genetic Algorithm Based Critical Experiment Design for Uranium Cross Section Validation

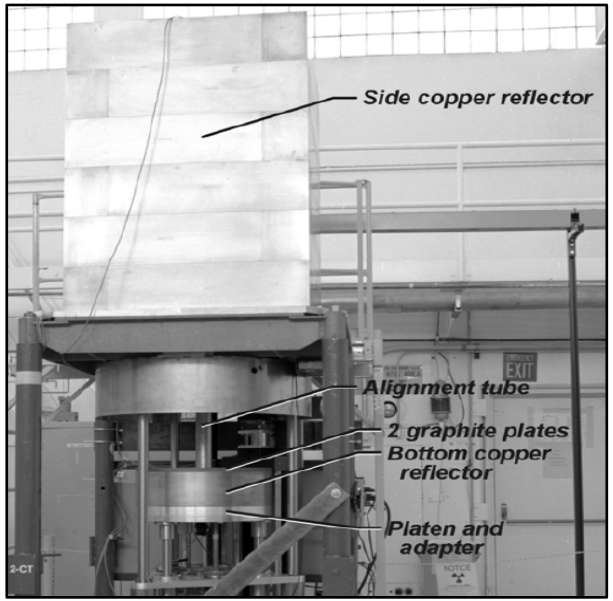
Dominik Fritz[1,2]

Mentors: Theresa Cutler[1], Rian Bahran[1], Jesson Hutchinson[1]

[1]Los Alamos National Laboratory

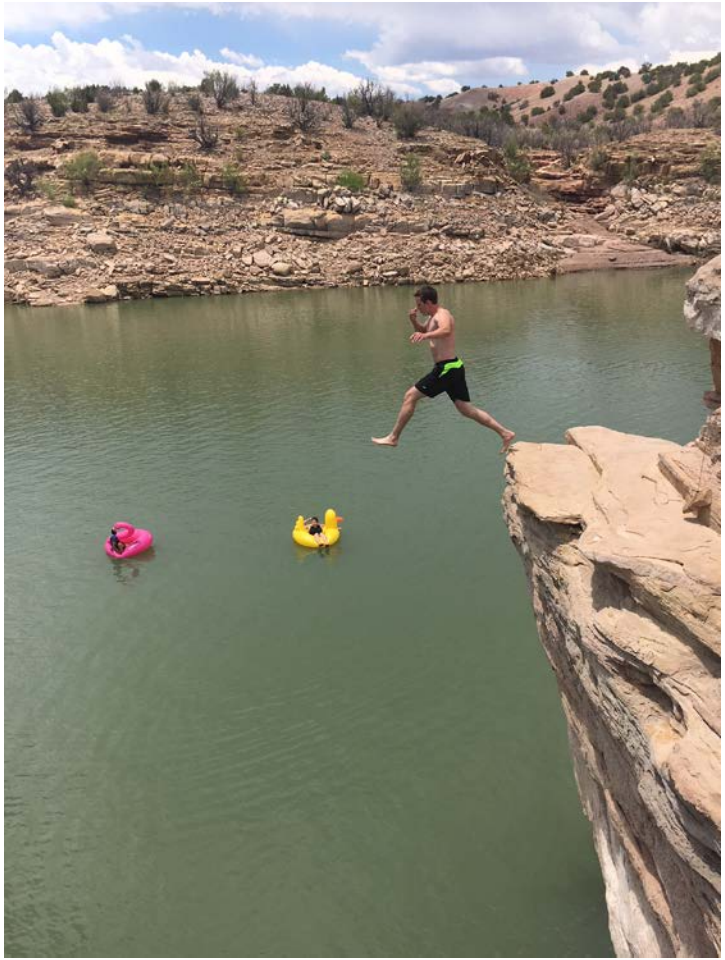
NEN-2 Advanced Nuclear Technology

[2]Rensselaer Polytechnic Institute



LA-UR-18-XXXX

Abiquiu Cliff Jumping

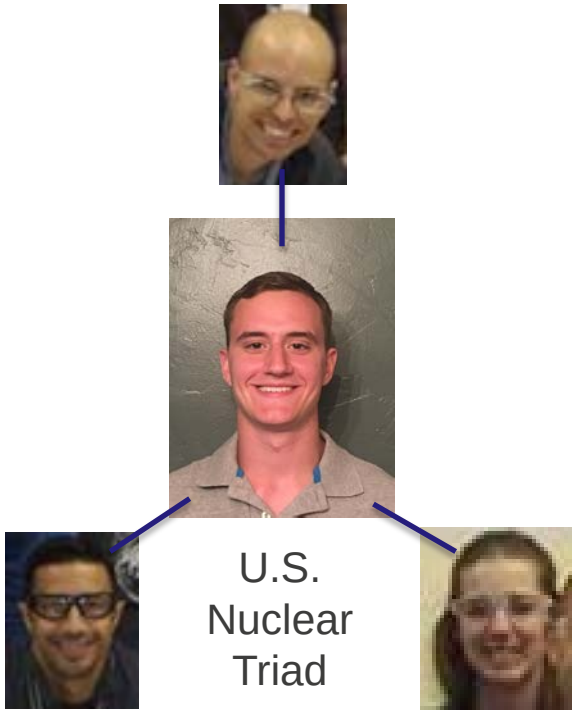


Dominik Fritz

- Educational Background
  - o BS Nuclear Engineering - RPI, Dec. 2018
  - o Ph.D. Nuclear Science and Engineering - RPI, 2018

- Group
  - o NEN-2 Advanced Nuclear Technology
  - o Theresa Cutler, Rian Bahran, Jesson Hutchinson

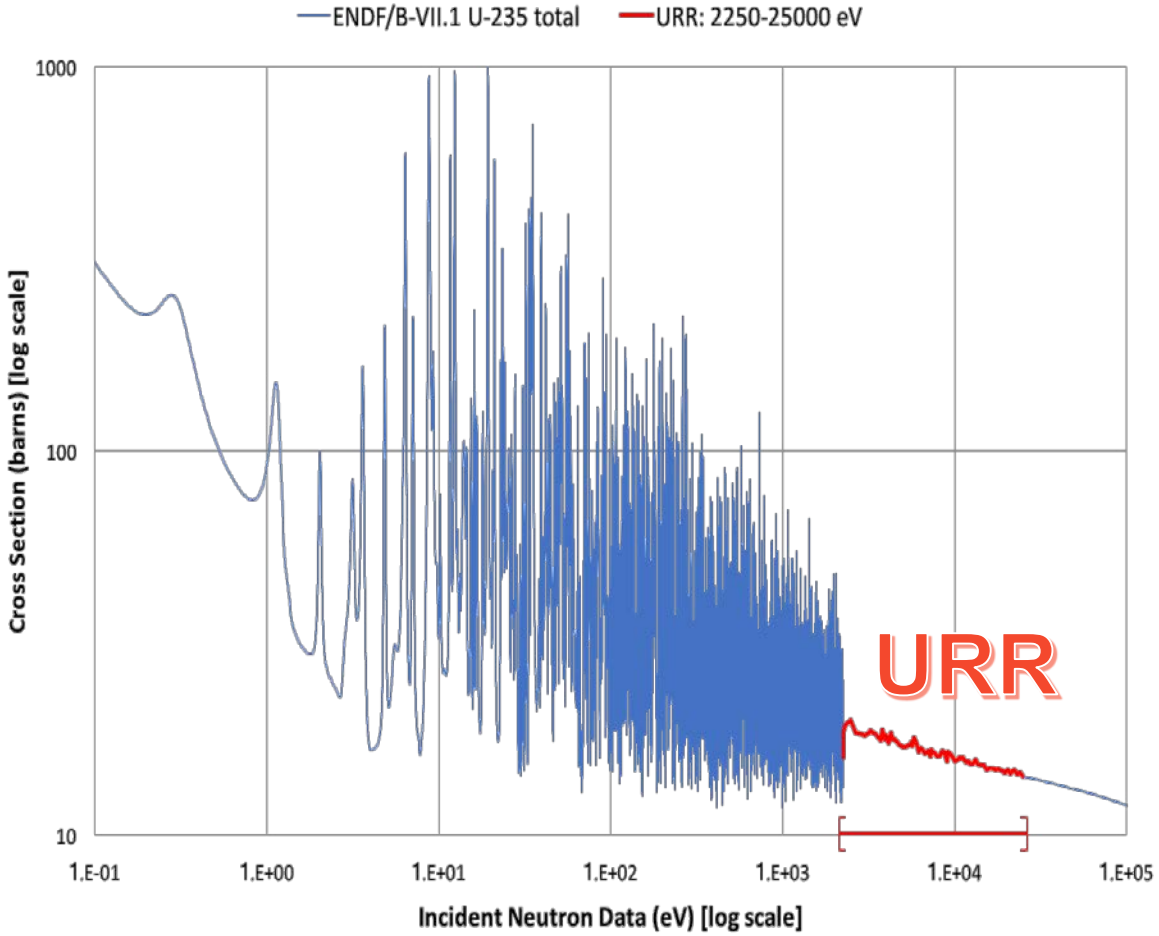
- Research
  - o Critical Experiment Design



Research Overview and Motivation

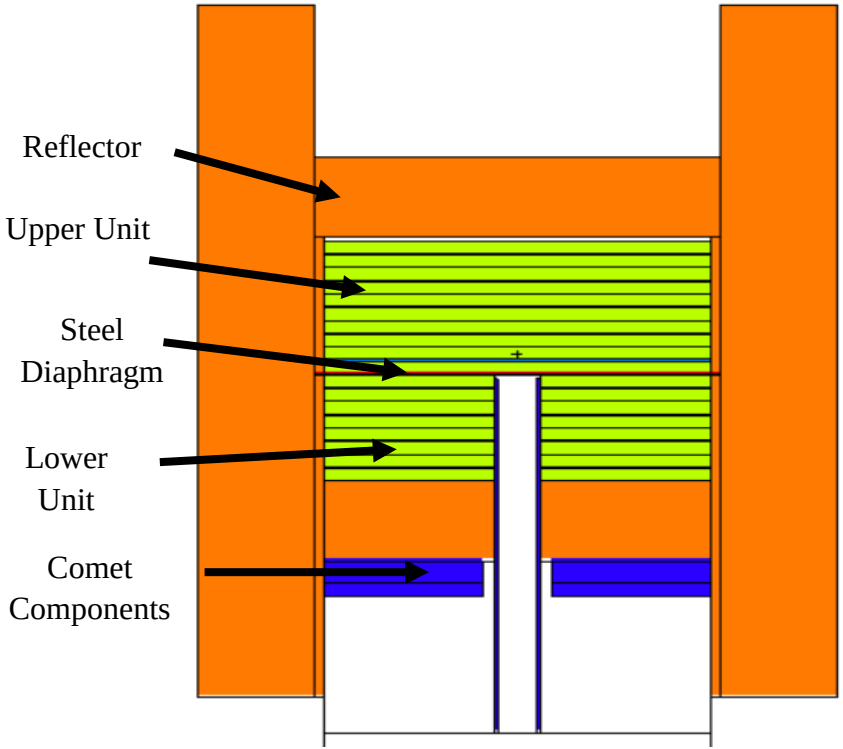
- **Purpose –** Validate new differential U-235 fission cross-section measurements in the Unresolved Resonance Region (URR)

- **Motivation**
  - Modeling and simulation depend on the accuracy of underlying differential nuclear data
  - U-235 fission cross section validation enhances the of safety of all uranium based nuclear systems



Research Approach

- The primary method of nuclear data validation is the use of critical experiments
- A genetic algorithm was employed to optimize the design of the critical experiment on the largest fraction of fission sensitivity occurring in the URR using MCNP® 6.1.1.



Vertical cross section of the optimized Teflon moderated critical assembly

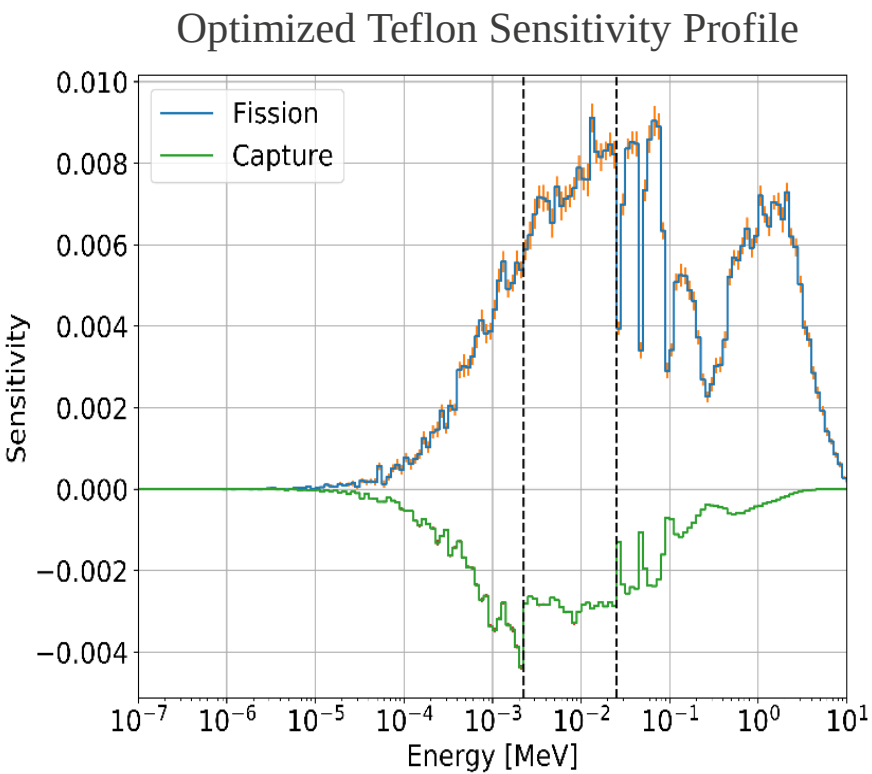
Summary of Results

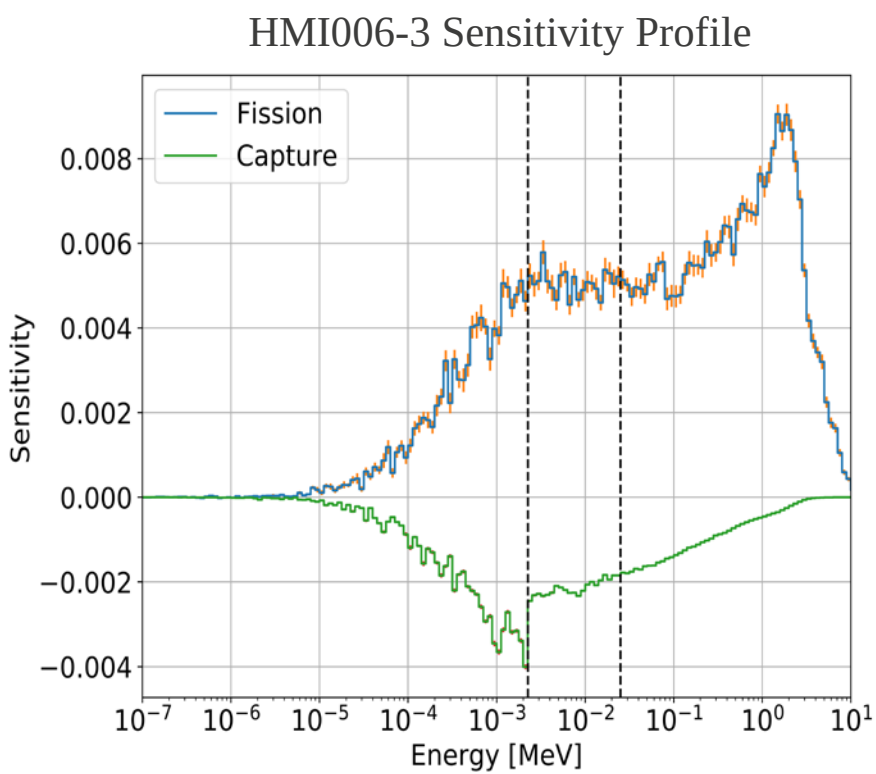
Optimized Moderator Material Comparisons

Material	Lucite	BeO	Be	HMI006-3	Graphite	Alumina	Teflon
Thickness [cm]	0.466	1.677	1.135	2.015	1.640	2.011	2.276
URR Fission Sensitivity Fraction	0.1027	0.2027	0.2096	0.2173	0.2202	0.2844	0.3087
URR Capture Sensitivity Fraction	0.0452	0.1007	0.0837	0.0906	0.0912	0.1074	0.1178
URR Fission Sensitivity Integral	0.4051	0.4143	0.4794	0.4889	0.4973	0.5104	0.4967
URR Capture Sensitivity Integral	0.1829	0.1980	0.1689	0.1550	0.1458	0.1418	0.1575
Fission Integral to Capture Integral	2.21	2.09	2.84	3.15	3.41	3.60	3.15
	Poor			Ok	Good	Better	Great

- URR Fission Sensitivity Fraction = Optimized Parameter, therefore Teflon is optimal material

Sensitivity Profiles – Teflon vs. HMI006-3





- Teflon has a significantly higher fraction of fission sensitivity in the URR than HMI006-3